Patent claims:

1. A process for determining the actual position of a structure of an object to be examined (1) in a coordinate system, whereby a CT scanner is employed which uses CT technology, having a first coordinate system, the CT coordinate system, related to said CT scanner, and a coordinate measuring instrument (MI) is employed which is either a tactile or an optical coordinate measuring instrument or a multisensor coordinate measuring instrument or an ultrasonic coordinate measuring instrument, having a second coordinate system, the MI coordinate system, related to said coordinate measuring instrument, whereby

a) the coordinates of the object to be examined (1) are determined in the MI coordinate system,

b) a target position of the structure within the object to be examined (1) is predefined,

c) after the execution of steps a) and b), the target position is determined in the MI coordinate system,

d) and, using the result of step c), the object to be examined (1) is positioned in such a way that the target position of the structure comes to lie within the volume detected by the CT scanner.

2. A process for determining the actual position of a structure of an object to be examined (1) in a coordinate system, whereby a CT scanner is employed which uses CT technology, having a first coordinate system, the CT coordinate system, related to said CT scanner, and a coordinate measuring instrument is employed which is either a tactile or an optical coordinate measuring instrument or a multisensor coordinate measuring instrument or an ultrasonic coordinate measuring instrument, having a second coordinate system, the MI coordinate system, related to said coordinate measuring instrument, whereby

a) the coordinates of the object to be examined (1) are determined in the CT coordinate system,

b) a target position of the structure within the object to be examined (1) is predefined,

c) after the execution of steps a) and b), the target position is determined in the CT coordinate system,

d) and, using the result of step c), the object to be examined (1) is positioned in such a way that the target position of the structure comes to lie within the area that can be detected by the coordinate measuring instrument.

3. The process according to Claim 1, characterized in that,
in the case of a predefined target position of the structure, relative to at least three selected, non-co-linear points of the object to be examined (1), the object to be examined is positioned using the coordinate measuring instrument in such a way that at least a part of the object to be examined (1) lies within the volume detected by the CT scanner and this part of the object to be examined (1) contains the target position of the structure.

4. The process according to Claim 3, characterized in that,
at a predefined maximum deviation of the target position from the actual position of the structure of the object to be examined (1), said object is positioned using the coordinate measuring instrument in such a way that the target position as well as the actual position of the structure lie within the volume detected by the CT scanner.

5. The process according to Claim 4, characterized in that,

- the actual position differs from the target position by a predefined tolerance deviation at the most, so that the actual position lies within a tolerance volume whose edge is at a distance from the target position by the tolerance deviation at the most, and
- the object to be examined is positioned using the coordinate measuring instrument in such a way that the tolerance volume lies completely within the volume detected by the CT scanner.

6. The process according to Claim 5, characterized in that

the tolerance volume is a sphere, a tolerance sphere, whose mid-point coincides with the target positions and whose radius is predefined by the amount of the maximum deviation of the target position from the actual position of the structure.

7. The process according to Claim 5 or 6, characterized in that the object to be examined is positioned using the coordinate measuring instrument in such a way that the volume detected by the CT scanner has, at the most, the x-fold volume of the tolerance sphere or of the tolerance volume, whereby x is a predefinable number that is preferably greater than 1.

8. The process according to Claim 2, characterized in that

- in the case of a predefined target position of the structure, relative to at least three selected, non-co-linear points of the object to be examined (1), the object to be examined (1) is positioned using the CT scanner in such a way that at least a part of the object to be examined (1) lies within the area that can be detected by the coordinate measuring instrument and this part of the object to be examined (1) contains the target position of the structure,
- at a predefined maximum deviation of the target position from the actual position of the structure of the object to be examined (1), said object is positioned using the CT scanner in such a way that the target position as well as the actual position of the structure lie within the area that can be detected by the coordinate measuring instrument,
- the actual position differs from the target position by a predefined tolerance deviation at the most, so that the actual position lies within a tolerance area whose edge is at a distance from the target position by the tolerance deviation at the most,
- the object to be examined (1) is positioned using the CT scanner in such a way that the tolerance area lies completely within the area that can be detected by the coordinate measuring instrument.

9. The process according to one of the Claims 1 to 8, characterized in that the relative location and the relative orientation of the CT coordinate system relative to

the MI coordinate system are predefined or can be determined by means of calibration.

10. The process according to Claim 3 and 9, characterized in that,

(i) by means of the coordinate measuring instrument, the location of the at least three selected points of the object to be examined (1) is determined relative to the MI coordinate system,

(ii) the target position of the structure relative to the MI coordinate system is calculated using the measured results obtained in step (i), and

(iii) the target position of the structure is converted from the MI coordinate system to the CT coordinate system so that subsequently the location of the target position in the CT coordinate system is known.

11. The process according to Claim 10, characterized in that the object to be examined (1) is positioned relative to the CT scanner by means of a traveling mechanism (3), using the target position of the structure obtained by means of step (iii) with respect to the CT coordinate system, in such a way that the tolerance volume and thus also the structure lie within the volume detected by the CT scanner.

12. The process according to one of the Claims 1 to 11, characterized in that, using the CT scanner, a three-dimensional digital CT image of the tolerance volume, including the structure, is created and stored as a CT data record, and the actual position of the structure is determined in the CT coordinate system on the basis of the CT data record.

13. The process according to Claim 8, characterized in that

(i) by means of the CT scanner, the location of the at least three selected points of the object to be examined (1) is determined relative to the CT coordinate system,

(ii) the target position of the structure relative to the CT coordinate system is calculated using the measured results obtained in step (i),

(iii) the target position of the structure is converted from the CT coordinate system to the MI coordinate system so that subsequently the location of the target position in the CT coordinate system is known,

(iv) the object to be examined (1) is positioned relative to the coordinate measuring instrument by means of a traveling mechanism (3), using the target position of the structure obtained by means of step (iii) with respect to the MI coordinate system, in such a way that the tolerance volume and thus also the structure lie within the area that can be detected by the coordinate measuring instrument, and

(v) using the coordinate measuring instrument, a three-dimensional digital image of the tolerance area, including the structure, is created and stored as an MI data record, and the actual position of the structure is determined in the MI coordinate system on the basis of the MI data record.

14. The process according to Claim 1, characterized in that,

- the CT scanner used is one that has an X-ray source (5) and a two-dimensional, position-resolving detector (6) having an active detector surface that is sensitive to the radiation emitted by the X-ray source (5), whereby the image field of the CT scanner is defined by the size of the active detector surface,
- the target position of the structure, relative to at least three selected, non-co-linear points of the object to be examined (1), is predefined, and the actual position differs from the target position by a tolerance deviation at the most, so that the actual position lies within a, for example, spherical tolerance volume whose edge is at a distance from the target position by the tolerance deviation at the most, and
- the relative location and the relative orientation of the CT coordinate system relative to the MI coordinate system are known or are determined by means of calibration;

and the following steps are carried out:

a) by means of the coordinate measuring instrument, the location of the at least three selected points of the object to be examined (1) are determined relative to the MI coordinate system,

b) the target position of the structure relative to the MI coordinate system is calculated using the measured results obtained in step a),

c) the target position of the structure is converted from the MI coordinate system to the CT coordinate system, so that the location thereof in the CT coordinate system is known,

d) the relative position of the object to be examined (1) is regulated with respect to the CT scanner by means of a traveling mechanism (3), using the target position of the structure obtained by means of step c) relative to the CT coordinate system, in such a way that the tolerance volume and thus also the structure lie within the volume that can be detected by the CT scanner,

e) by means of the CT scanner, a three-dimensional digital CT image of the tolerance volume, including the structure, is created and stored as a CT data record, and

f) the actual position of the structure is determined in the CT coordinate system on the basis of the CT data record.

15. The process according to Claim 14, characterized in that the tolerance volume is a tolerance sphere, so that its radius is defined by the tolerance deviation and its mid-point is defined by the target position.

16. The process according to Claim 14 or 15, characterized in that the CT scanner in process step d) is regulated in such a way that the center of the tolerance volume is essentially located in the center of the volume that can be detected by the CT scanner.

17. The process according to one of the Claims 14 to 16, characterized in that the CT scanner is regulated in such a way that, with the centered projection of the tolerance volume with the X-ray source (5) as the center of projection, the image field is completely filled by the projection of the tolerance volume onto the detector.

18. The process according to one of the Claims 16 or 17, characterized in that

the CT scanner is regulated in such a way that, with the centered projection of the tolerance volume with the X-ray source (5) as the center of projection

- the smallest diameter of the projection of the tolerance volume onto the detector and the smallest diameter of the image field of the CT scanner are essentially equal in size, or
- the largest diameter of the projection of the tolerance volume onto the detector and the largest diameter of the image field of the CT scanner are essentially equal in size, or
- the largest diameter of the projection of the tolerance volume onto the detector and the smallest diameter of the image field of the CT scanner are essentially equal in size.

19. The process according to one of the Claims 1 to 18, characterized in that, in addition to the location of the structure, the shape of the structure is also determined on the basis of the CT image or the CT data record.

20. The process according to one of the Claims 1 to 18, characterized in that the shape of the structure rather than the location of the structure is determined on the basis of the CT image or the CT data record.

21. The process according to one of the Claims 1 to 20, characterized in that the position of at least three, preferably at least four, selected space points of a calibration object is determined with the CT scanner in the CT coordinate system as well as with the coordinate measuring instrument in the MI coordinate system, and the comparison of the results thus obtained makes it possible to determine the relative location and the relative orientation of the CT coordinate system relative to the MI coordinate system.

22. The process according to Claim 21, characterized in that the object to be examined (1) and the calibration object are identical.

23. The process according to one of the Claims 1 to 22, characterized in that,

A) the object to be examined (1) is rotated incrementally around an axis of rotation in order to create the CT image,

B) for each of the rotational positions that the object to be examined (1) thus passes through, a two-dimensional transmission X-ray image of the object to be examined (1) is taken with the detector (6), and

C) the three-dimensional CT image is created on the basis of the two-dimensional transmission X-ray images thus obtained.

24. The process according to Claim 23, characterized in that,

D) after steps A) and B) have been carried out, the object to be examined (1) is shifted translatorily by a certain distance, preferably in a direction parallel to the axis of rotation, and then once again rotated incrementally around the axis of rotation;

E) for each of the rotational positions that the object to be examined passes through in step D), a two-dimensional transmission X-ray image of the object to be examined (1) is once again taken with the detector (6), and

F) another three-dimensional CT image is created on the basis of the two-dimensional transmission X-ray image obtained in step E).

25. A device for determining the actual position of a structure of an object to be examined (1) in a coordinate system,

- with a CT scanner having a first coordinate system, the CT coordinate system, related to said CT scanner,
- and with a coordinate measuring instrument which is either a tactile or an optical coordinate measuring instrument or a multisensor coordinate measuring instrument or an ultrasonic coordinate measuring instrument, having a second coordinate system, the MI coordinate system, related to said coordinate measuring instrument,

whereby the coordinates of the object to be examined (1) can be determined in the MI coordinate system, and a target position of the structure within the object to be examined(1) is predefined, so that

- the target position can be determined in the MI coordinate system,

- and the object to be examined (1) can be positioned in such a way that the target position of the structure comes to lie within the volume detected by the CT scanner,

whereby the CT scanner and the multisensor coordinate measuring instrument are integrated into one single device.

26. The device according to Claim 25, characterized in that,
in the case of a predefined target position of the structure, relative to at least three selected, non-co-linear points of the object to be examined (1), the object to be examined can be positioned using the coordinate measuring instrument in such a way that at least a part of the object to be examined (1) lies within the volume detected by the CT scanner and this part of the object to be examined (1) contains the target position of the structure.

27. The device according to Claim 25, characterized in that,
at a predefined maximum deviation of the target position from the actual position of the structure of the object to be examined (1), said object can be positioned using the coordinate measuring instrument in such a way that the target position as well as the actual position of the structure lie within the volume detected by the CT scanner.

28. The device according to Claim 27, characterized in that,

- the actual position differs from the target position by a predefined tolerance deviation at the most, so that the actual position lies within a tolerance volume whose edge is at a distance from the target position by the tolerance deviation at the most, and
- the object to be examined can be positioned using the coordinate measuring instrument in such a way that the tolerance volume lies completely within the volume detected by the CT scanner.

29. The device according to Claim 28, characterized in that

the tolerance volume is a sphere, a tolerance sphere, whose mid-point coincides with the target positions and whose radius is predefined by the amount of the maximum deviation of the target position from the actual position of the structure.

30. The device according to Claim 28 or 29, characterized in that the object to be examined can be positioned using the coordinate measuring instrument in such a way that the volume detected by the CT scanner has, at the most, the x-fold volume of the tolerance sphere or of the tolerance volume, whereby x is a predefinable number that is preferably greater than 1.

31. The device according to one of Claims 25 to 30, characterized in that the relative location and the relative orientation of the CT coordinate system relative to the MI coordinate system are predefined or can be determined by means of calibration.

32. The device according to Claim 31, characterized in that,

(i) by means of the coordinate measuring instrument, the location of the at least three selected points of the object to be examined (1) can be determined relative to the MI coordinate system,

(ii) the target position of the structure relative to the MI coordinate system can be calculated using the measured results obtained in step (i), and

(iii) the target position of the structure can be converted from the MI coordinate system to the CT coordinate system so that the location of the target position can be determined in the CT coordinate system.

33. The device according to Claim 32, characterized in that the object to be examined (1) can be positioned relative to the CT scanner by means of a traveling mechanism (3), using the target position of the structure obtained by means of step (iii) with respect to the CT coordinate system, in such a way that the tolerance volume and thus also the structure lie within the volume detected by the CT scanner.

34. The device according to one of Claims 25 to 33, characterized in that,

using the CT scanner, a three-dimensional digital CT image of the tolerance volume, including the structure, can be created and stored as a CT data record, and the actual position of the structure in the CT coordinate system can be determined on the basis of the CT data record.

35. The device according to Claim 25, characterized in that,

- the CT scanner has an X-ray source (5) and a two-dimensional position-resolving detector (6) having an active detector surface that is sensitive to the radiation emitted by the X-ray source (5),
- the image field of the CT scanner is defined by the size of the active detector surface,
- the target position of the structure, relative to at least three selected, non-co-linear points of the object to be examined (1), is predefined and the actual position differs from the target position by a tolerance deviation at the most, so that the actual position lies within a, for example, spherical tolerance volume whose edge is at a distance from the target position by the tolerance deviation at the most, and
- the relative location and the relative orientation of the CT coordinate system relative to the MI coordinate system are known or can be determined by means of calibration,

whereby

a) by means of the coordinate measuring instrument, the location of the at least three selected points of the object to be examined (1) can be determined relative to the MI coordinate system,

b) the target position of the structure relative to the MI coordinate system can be calculated from this,

c) the target position of the structure can be converted from the MI coordinate system to the CT coordinate system, so that the location thereof can be determined in the CT coordinate system,

d) the relative position of the object to be examined (1) relative to the CT scanner can be regulated by means of a traveling mechanism (3), using the target position of the structure relative to the CT coordinate system, in such a

way that the tolerance volume and thus also the structure lie within the volume that can be detected by the CT scanner, and

e) the CT scanner can create a three-dimensional digital CT image of the tolerance volume, including the structure, and can store it as a CT data record,

so that the actual position as well as the shape of the structure can be determined in the CT coordinate system on the basis of the CT data record.

36. The device according to Claim 35, characterized in that the tolerance volume is a tolerance sphere, so that its radius is defined by the tolerance deviation and its mid-point is defined by the target position.

37. The device according to Claim 35 or 36, characterized in that the CT scanner can be regulated in such a way that the center of the tolerance volume is located essentially in the center of the volume that can be detected by the CT scanner.

38. The device according to one of Claims 35 to 37, characterized in that the CT scanner can be regulated in such a way that, with the centered projection of the tolerance volume with the X-ray source (5) as the center of projection, the image field is completely filled by the projection of the tolerance volume onto the detector.

39. The device according to one of Claims 35 to 37, characterized in that the CT scanner can be regulated in such a way that, with the centered projection of the tolerance volume with the X-ray source (5) as the center of projection,

- the smallest diameter of the projection of the tolerance volume onto the detector and the smallest diameter of the image field of the CT scanner are essentially equal in size, or
- the largest diameter of the projection of the tolerance volume onto the detector and the largest diameter of the image field of the CT scanner are essentially equal in size, or

- the largest diameter of the projection of the tolerance volume onto the detector and the smallest diameter of the image field of the CT scanner are essentially equal in size.

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